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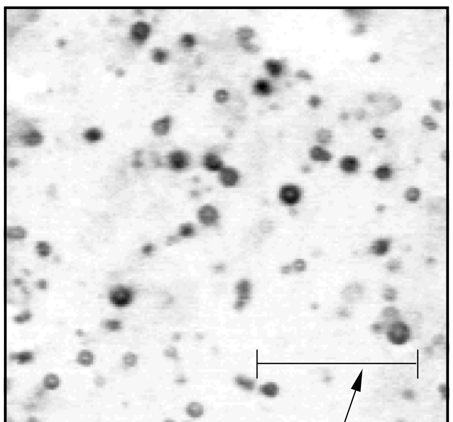
Bubble Detectors Show Promise for High-Resolution Neutron Imaging on the NIF. High-resolution neutron imaging is an important Phase II diagnostic for the National Ignition Facility (NIF). Based on studies of ignition capsule failure modes using LASNEX, the current resolution specification for a neutron imaging system is 5 µm. The most critical factor in the design of a low-magnification imaging system is high spatial resolution for neutron detection. Low magnification and high-resolution detection significantly ease the requirements on aperture fabrication, characterization, alignment, and standoff from target.

Recent experiments at the University of Rochester's Laboratory for Laser Energetics (UR-LLE) OMEGA laser using customized bubble detectors based on a commercial neutron dosimeter clearly show that an image created by a penumbral aperture is properly encoded in the distribution of bubbles in the detector. The figures show an example of the bubbles created by neutron exposure and the resulting image reconstructed from the positions of several hundred bubbles created on a high-yield OMEGA shot. Detailed analysis shows that the image resolution is limited, as expected, by the detection statistics. The detection efficiency is estimated to be <1% that of a liquid bubble chamber, which is the next step in the development of an imaging system for the NIF. With liquid bubble chambers, it should be possible to achieve the 5-µm specification at neutron yields as low as 10^{15}.



Microscope photo shows small area of bubble detector. Average bubble is ~75 µm in diameter.

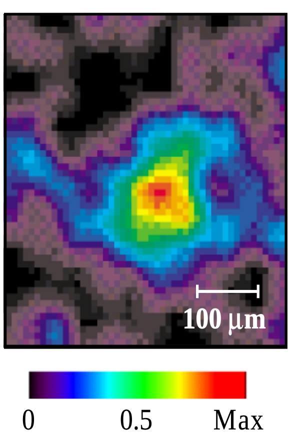
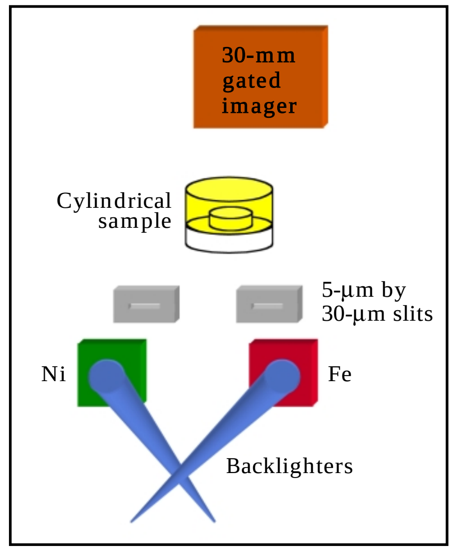
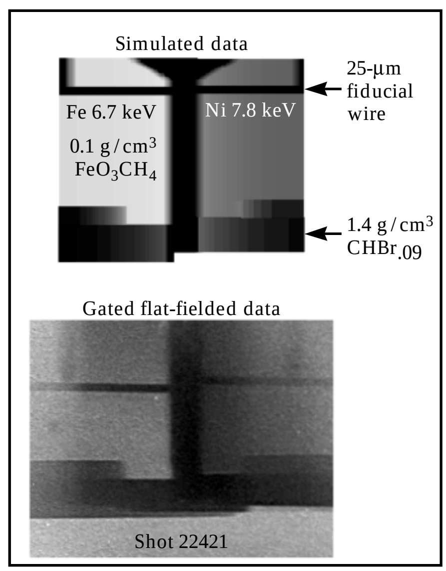


Image reconstructed from measured bubble positions.

Dual Color Radiography. Experiments at the UR-LLE OMEGA laser demonstrated a new two-color, high-spatial and high-temporal-resolution, multi-keV radiography technique. The technique allows the fraction and density of two materials to be determined, even when mixed together. Shown in the top figure is the proof-of-principle experimental setup which uses a 6.7-keV Fe He-like resonance line and 7.8-keV Ni He-like resonance line to probe with two frequencies or "colors" the same object. The colors have been chosen such that they straddle the absorption edge of one of the materials, in this case the Fe K edge in the doped foam shown in yellow. The radiography is done by projection of a line source set by backlighting two short slits. The slits allow for high resolution (4 µm measured in this case) in one direction while averaging in the orthogonal direction for improving photon collection efficiency and hence signal-to-noise. On the bottom, the predicted vs measured radiographs are compared, where lighter equates to more transmission. As expected, the Fe-doped foam transmits more of the lower energy 6.7-keV line below its K edge. By contrast, the Br-doped plastic with no absorption edges in this region transmits less of the lower energy line.





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